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Eldonia berbera n. sp., a new species of the enigmatic genus *Eldonia* Walcott, 1911 from the Rawtheyan (Upper Ordovician) of Anti-Atlas (Erfoud, Tafilalt, Morocco)

Abstract – *Eldonia berbera* n. sp., a new species of the enigmatic genus *Eldonia* Walcott, 1911 is here described. Seventyone specimens from Upper Ordovician (Rawtheyan) of Morocco (Erfoud, Tafilat) have been considered. These eldoniids are the youngest records of Ediacara-type preservation. The same preservation in Erfoud Ordovician sandstones has been observed also on enigmatic 'archnomorphs' arthropods.

Key-words – Ordovician, enigmatic metazoans, Ediacara-type preservation.

Riassunto – *Eldonia berbera* n. sp., una nuova specie del genere enigmatico *Eldonia* Walcott, 1911 del Rawtheyano (Ordoviciano superiore) dell'Anti-Atlante (Erfoud, Tafilalt, Marocco).

Viene qui descritta *Eldonia berbera* n. sp., nuova specie del genere enigmatico *Eldonia* Walcott, 1911. Sono stati esaminati 71 esemplari rinvenuti nell'Ordoviciano superiore (Rawtheyano) del Marocco (Erfoud, Tafilalt) che rappresentano la più recente testimonianza della conservazione di tipo ediacariano. Questo stesso tipo di conservazione è stato inoltre osservato in artropodi 'aracnomorfi' di incerta collocazione sistematica rinvenuti anch'essi nelle arenarie ordoviciane di Erfoud.

Parole chiave – Ordoviciano, metazoi enigmatici, conservazione di tipo ediacariano.

Introduction

This work reports the results of an investigation of fossil remains from Rawtheyan (Upper Ordovician) of Morocco that we assign to a new species of *Eldonia* Walcott, 1911. *Eldonia* is the nominal taxon of Eldoniidae Walcott, 1911, a family that has never been ascribed unequivocally to a higher taxonomic category (Wills & Sepkoski, 1993). Two species of *Eldonia* have been described: *Eldonia ludwigi* Walcott, 1911, from the Middle Cambrian of Canada (Walcott, 1911), Utah (Conway Morris & Robinson, 1988) and Siberia (Friend & Zhuravlev, 1995; Ivantsov, 1998) and *Eldonia eumorpha* (Sun & Hou, 1987), from the Lower Cambrian of China (Sun & Hou, 1987).

All samples come from the Erfoud area, in the sub-desertic region of Tafilalt (south-eastern Morocco), but only 75% of them are known with certainty to have

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come from the type locality of Moroccan *Eldonia* fossils (Fig. 1). Wide outcrops of Ordovician sandstones overlain by Quaternary (Destombes & Hollard, 1987) characterize the Erfoud area in the north-eastern part of the Anti-Atlas. The *Eldonia* specimens reported here come from Ordovician sandstones.

Several sandstone slabs from Erfoud preserve ripple-marks, mud-cracks and

Fig. 1 – Geographical map of Morocco.
Fig. 1 – Carta geografica del Marocco.

bioturbations: the portion of Gondwanaland nowadays corresponding to Morocco, was covered during the Ordovician (Whittington & Hughes, 1972; Destombes *et al.*, 1985) by one of the epicontinental seas typical of this geological period (Jaanusson, 1984; Mac Niocaill *et al.*, 1997).

In addition to chitinozoans, conulariids, brachiopods and trilobites, the Ordovician sandstones from Erfoud preserve some enigmatic fossil remains referable to the medusoid metazoan *Protolyella* Torell, 1870 and to 'arachnomorphs' arthropods previously related to aglaspidids by Samuelsson *et al.* (2001). *Protolyella*, like *Eldonia*, seems to lack tissues mineralized in life (Plummer, 1980; Seilacher, 1994). On the basis of chitinozoans and acritarchs, Samuelsson *et al.* (2001) assigned the Erfoud sandstones to Lower Rawtheyan and to the highest part of the Upper Ktaoua Formation. The chronostratigraphic range of this formation reaches Upper Pusgillian at the base, Middle Rawtheyan at the top (Elouad Debbaj, 1984; Destombes *et al.*, 1985).

Eldonia fossil record

All examples of *Eldonia* previously reported are Cambrian in age (Wills & Sepkoski, 1993).

From the Lower Cambrian of Chengjiang (Yunnan Province, south-eastern

China) are the specimens formerly described by Sun & Hou (1987) as *Stellostomites eumorphus* Sun & Hou, 1987 and *Yunnanomedusa eleganta* Sun & Hou, 1987 (Class Schyphozoa) and later assigned by Chen *et al.* (1995) to the species *E. eumorpha*. More recently Zhu *et al.* (2002) reintroduced the genus *Stellostomites* Sun & Hou, 1987 for the *Eldonia* Chinese specimens. Neverthless in our view there are not sufficient morphological differences between *Eldonia* and *Stellostomites* to fully justify Zhu *et al.*'s choice.

Records of *E. ludwigi* all date to the Middle Cambrian (Wills & Sepkoski, 1993). The first specimens were collected in 1910 (Walcott, 1911) from the Middle Cambrian Burgess Shale of British Columbia (Conway Morris & Whittington, 1985; Briggs *et al.*, 1994).

In 1967 I. Solov'ev from the St. Petersburg Geological Museum (Russia) collected one specimen of *E. ludwigi* near a locality situated on the eastern slopes of the Anabar Massif, in north-eastern Siberia (Friend & Zhuravlev, 1995).

More recently Ivantsov (1998) reported other Russian Eldoniidae from the Sinsk Formation (Lower Cambrian) and the Silinde Formation (Middle Cambrian) that outcrop in the southern and northern part of Siberian Platform respectively. Neverthless, according to Zhu *et al.* (2002), among these fossils only one specimen from the Silinde Formation is referable to *E. ludwigi*.

In a study of some soft-bodied organisms and algae from Utah Middle Cambrian, Conway Morris & Robinson (1988) reported two new specimens of *E. ludwigi* from two different sites. One came from the Wellsville Mountains (north-eastern Utah), a few kilometres north of Brigham City, while the second was collected in the House Range (Western Utah), near the Swasey Mount.

The discovery of *Eldonia* specimens in the Erfoud Ordovician sandstones extend the stratigraphic range known for this taxon (Wills & Sepkoski, 1993): no longer from Lower Cambrian (Chinese records) to Middle Cambrian (American and Siberian records) but, according to Samuelsson *et al.* (2001), up to the Upper Ordovician (Ashgill).

Materials and methods

Seventyone specimens of *Eldonia* were examined but only for 52 of them is known the type locality. This locality was visited by one of the authors during an expedition organized by the Museo Civico di Storia Naturale of Milan in collaboration with the Geological Survey of Morocco. The specimens investigated are now part of the Paleontological Collections of the Museo Civico di Storia Naturale of Milan and are labelled 'MSNM' followed by the series number of the invertebrate collection. The specimens on the same slab are indicated by the slab series number followed by the symbol '#' and an identification number between 1 and 3.

For each specimen the following dimensions were measured (Fig. 2): radius (R) or average radius ($R_m = (R_{max} + R_{min}) / 2$) where the elliptical shape of specimens made it necessary to measure the maximum radius (R_{max}) and the minimum one (R_{min}), outer ring width (L_{ap}), maximum width of the curved sac (L_{sc}) and the total number of radial ridges (C_r). Because of the low preservation quality, in some specimens C_r was counted for only 1/4 or 1/6 of the disk.

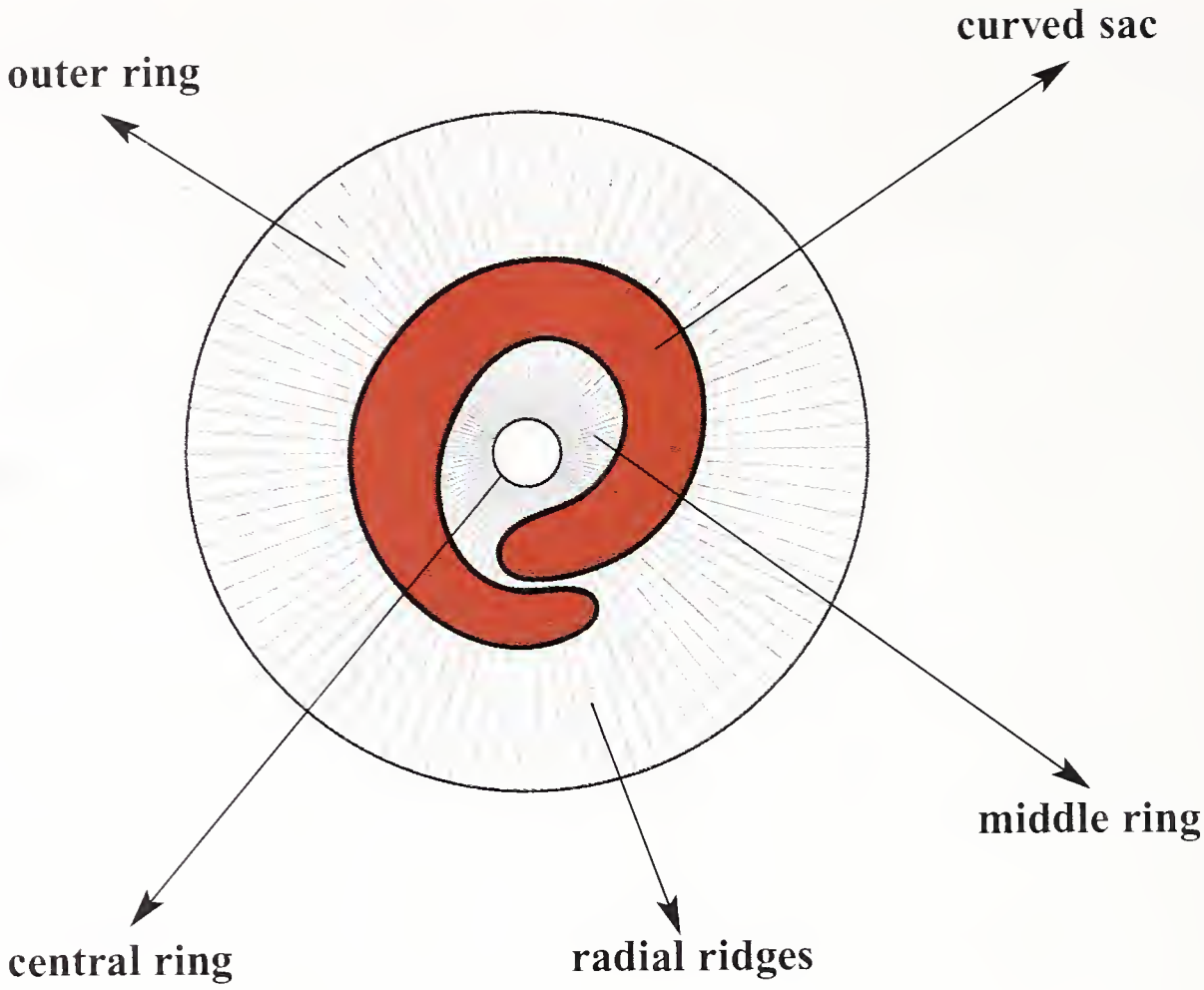

Fig. 2 – Schematic reconstruction of *Eldonia berbera* n. sp.
Fig. 2 – Ricostruzione schematica di *Eldonia berbera* n. sp.

Preservation

The specimens are disk-shaped imprints in a yellow-brown, sometimes reddish, sandstone and are preserved as parts (B, negative hyporelief or external mold) and counterparts (A, positive epirelief or counterpart cast). For 5 specimens both part and counterpart, for 17 specimens only the part, for 31 only the counterpart are available. In 18 samples this distinction has not been possible because of the fragmentary nature or poor preservation of the specimens (Tab. 1). Parts preserve curved sac as concave hyporelief, counterparts as convex epirelief. In 54 specimens (Tab. 2) the preserved body outline is circular (13 specimens) or more often elliptical (41 specimens). The circular body outline is the one that shows the real shape of *Eldonia*, the elliptical one should be regarded as a product of distortion according to the observations of Chen *et al.* (1995) and Friend (1995) on *E. eumorpha* and *E. ludwigi* respectively.

In some samples (MSNM i24818, MSNM i24819, MSNM i24826, MSNM i24832, MSNM i24836, MSNM i25330, MSNM i25331, MSNM i25269 and MSNM i25271) two or three specimens occur on the same slab, separated by a distance of no more than 25 cm. This could be evidence of a mass mortality stranding event (Bruton, 1989).

The preservation of *Eldonia* from Erfoud, like *Protolyella* and the enigmatic 'arachnomorphs' from the same area, can be compared (Samuelsson *et al.*, 2001) to that of Ediacara-type fossils (Gehling, 1999) from various parts of the world (Glaessner, 1984; Seilacher, 1984; Fedonkin, 1992; Jenkins, 1992) usually of late Neoproteorozoic age, an interval of six million years (Grotzinger *et al.*, 1995; Narbonne & Gehling, 2003). Examples of Ediacara-type conservation have also been recorded in Paleozoic fossil associations (Runnegar & Fedonkin, 1992;

Conway Morris, 1993a; Crimes *et al.*, 1995; Jensen, 1997; Jensen *et al.*, 1998; Hagadorn *et al.*, 2000) but never younger than Cambrian. Thus *Eldonia* and *Protolyella* from Ordovician sandstones of Morocco are the youngest records of Ediacara-type preservation.

The record in Erfoud sandstones of some enigmatic 'arachnomorphs' arthropods, showing the same type of preservation of the Eldoniids, leads us to support the hypothesis that some primitive metazoans, such as *Eldonia* preserved in quartzose sandstones, possessed a biomineralized exoskeleton (Seilacher, 1984 and 1989; Retallack, 1994; Crimes *et al.*, 1995; Dzik, 1999). Since the 'arachnomorphs' had a mineralized exoskeleton, could the same type of preservation, observed for arthropods and medusoid fossils from Erfoud, imply that also *Eldonia* and other problematic metazoans (such as *Protolyella* from Late Precambrian of Australia, *Velumbrella czarnockii* Stasinka, 1960 from Middle Cambrian of Poland, and some medusoid fossils (Pickerill, 1982) from Upper Cambrian of New Brunswick) had an exoskeleton at some degree of mineralization? Further investigation of this issue is required. This hypothesis could be extended to other problematic taxa closely related to Eldoniidae (Friend, 1995; Zhu *et al.*, 2002), such as *Discophyllum* Hall, 1847 (Middle Ordovician of New York State and Silurian of South Australia), *Parapsonema* Clarke, 1900 (Upper Devonian of New York State), *Pararotadiscus* Zhu, Zhao & Chen, 2002 (Lower Cambrian of China) and *Rotadiscus* Sun & Hou, 1987 (Lower Cambrian of China).

Tab. 1 – Specimens of *Eldonia berbera* n. sp. for which both part and counterpart (A-B, 5 specimens), only the part (B, 31 specimens) or only the counterpart (A, 17 specimens) are preserved.

Tab. 1 - Esemplari di *Eldonia berbera* n. sp. di cui è conservata sia impronta che controimpronta (A-B, 5 individui), solo l'impronta (B, 31 individui) o solo la controimpronta (A, 17 individui).

A – B	B	A
MSNM i24815, MSNM i24816, MSNM i24817, MSNM i25265 e MSNM i25271#1	MSNM i22825, MSNM i24818#1, MSNM i24818#2, MSNM i24818#3, MSNM i24822, MSNM i24823, MSNM i24827, MSNM i24828, MSNM i24829, MSNM i24832#1, MSNM i24834, MSNM i24835, MSNM i24836#1, MSNM i24836#2, MSNM i25251, MSNM i25252, MSNM i25253, MSNM i25254, MSNM i25255, MSNM i25323, MSNM i25325, MSNM i25327, MSNM i25329, MSNM i25330#1, MSNM i25330#2, MSNM i25257, MSNM i25258, MSNM i25261, MSNM i25267, MSNM i25269#2 e MSNM i25270	MSNM i22843, MSNM i23147, MSNM i24819#1, MSNM i24819#2, MSNM i24820, MSNM i24821, MSNM i24824, MSNM i24825, MSNM i24826#1, MSNM i24830, MSNM i24831, MSNM i24833, MSNM i25321, MSNM i25322, MSNM i25324, MSNM i25269#1 e MSNM i25271#2

Tab. 2 – Specimens of *Eldonia berbera* n. sp. preserved as circular (13 specimens, on the left) or elliptical imprints (41 specimens, on the right).
Tab. 2 - Esemplari di *Eldonia berbera* n. sp. aventi forma circolare (13 individui, a sinistra) o forma ellittica (41 individui, a destra).

CIRCULAR SHAPE	ELLIPTICAL SHAPE
MSNM i22825, MSNM i22843, MSNM i24828, MSNM i24831, MSNM i24836#2, MSNM i25255, MSNM i25321, MSNM i25322, MSNM i25325, MSNM i25262, MSNM i25268, MSNM i25269#2 e MSNM i25271	MSNM i23147, MSNM i23149, MSNM i24815, MSNM i24816, MSNM i24817, MSNM i24818, MSNM i24819, MSNM i24820, MSNM i24821, MSNM i24822, MSNM i24823, MSNM i24824, MSNM i24825, MSNM i24826#1, MSNM i24827, MSNM i24829, MSNM i24830, MSNM i24832#2, MSNM i24833, MSNM i24834, MSNM i2483, MSNM i24836#1, MSNM i25252, MSNM i25253, MSNM i25254, MSNM i25323, MSNM i25324, MSNM i25329, MSNM i25330#1, MSNM i25331#1, MSNM i25256, MSNM i25257, MSNM i25258, MSNM i25259, MSNM i25260, MSNM i25261, MSNM i25263, MSNM i25264, MSNM i25265, i25267, MSNM i25269#1 e MSNM i25270

Systematic Paleontology

Family Eldoniidae Walcott, 1911
Genus *Eldonia* Walcott, 1911

Eldonia berbera n. sp.

Diagnosis: disk-shaped metazoans, with a medusoid body and lacking biomineralized tissues. Body composed of four concentric regions (Fig. 2): central ring, middle ring (between outer margin of central ring and inner margin of curved sac), curved sac and outer ring (between outer margin of curved sac and disk margin). Traces of radial ridges are present all over the outer ring surface, converging from the disk margin to the disk centre.

Etymology: from the Arabic *barbàr* that translates the Greek term *βάρβαρος*, at first indicating the inhabitants of western and southern Egypt and later also the autochthonous populations of north-western Africa.

Holotype: MSNM i23147 (Fig. 3)

Paratypes: MSNM i24817 (Fig. 4-5), MSNM i24818#1 (Fig. 6), MSNM i24821 (Fig. 7), MSNM i25330#1 (Fig. 8).

Type locality: Erfoud (Tafilalt, south-eastern Morocco, Anti-Atlas Region). Most specimens come from a site 15 km South-East from Erfoud and 30 km North-East from Rissani.

Geological age: Lower Rawtheyan (Upper Ordovician).

Description: the region included between the disk margin and the curved sac, indicated by Conway Morris & Robinson (1988) as 'outer region', always preserves traces of radial structures. These structures look like thin ridges (width: 1-2 mm) and show a radial distribution that form a complex developed all over the disk surface. In many specimens (Tab. 3) the outer ring preserves some thread-like ridges, thinner than the radial structures, showing concentric distribution pattern even sometimes strikingly distorted. These structures have been interpreted by some authors as muscle fibres (Walcott, 1911; Clark A.H., 1912; Chen *et al.*, 1995; Friend, 1995; Zhu *et al.*, 2002).

Between the central ring and the marginal one a curved sac is preserved. It is probably a disgestive organ showing spiral progress and preserved as concave hyporelief (in parts) or convex epirelief (in counterparts). Mouth and anus in Moroccan specimens can not be distinguished but, as in previous descriptions of *Eldonia* (Walcott, 1911; Durham, 1974; Chen *et al.*,1995; Friend, 1995), the two ends of the gut are evident. In parts the curved sac shows a dark-grey colour and forms a right-handed spiral relief; in counterparts it is preserved as a deep left-handed spiral depression. The different colour of curved sac in parts is probably due to organic material inside the alimentary canal at the time of death. Many specimens (Tab. 3) preserve some traces of radial structures, more obvious in counterparts, showing direct connection with those of outer ring. In the same specimens, the curved sac shows a close netlike ornamentation (Fig. 8), here observed for the first time in *Eldonia*, formed by the intersection between radial ridges and 8-10 rows of parallel and concentric thread-like ridges.

In some specimens (Tab. 3) the outer margin of the curved sac is surrounded by a deep depression from mouth (maximum width 10 mm) to anus (minimum width 2-3 mm).

In some specimens (Tab. 3) the middle ring preserves at most three millimetric and roughly elliptical depressions (in parts) or areas of raised relief (in counterparts). These structures, which are never in the same position inside the middle ring in the Moroccan specimens, could be the disarticulated remains of a feeding device formerly attached to the mouth (Walcott, 1911; Clark A.H., 1912 and 1913; Durham, 1971 and 1974; Chen *et al.*, 1995; Friend, 1995; Zhu *et al.*, 1995). The same region of the disk also preserves some traces of radial ridges that appear to be disrupted probably due to some taphonomic effect.

One specimen only (MSNM i25327) preserves concentric thread-like ridges in the middle ring, identical to those already described for the outer ring.

Traces of the structure referred by previous authors as 'central ring' (Walcott, 1911, Chen *et al.*, 1995, Friend, 1995; Zhu *et al.*, 2002) or 'central complex' (Durham, 1974), have been observed only in one specimen (MSNM i24817A, Fig. 5), where they look like short curvilinear ridges which are thicker than either the radial ridges or the thread-like ridges.

Measurements: measurements details are reported in Tab. 4. For each parameter the most represented dimensional classes are reported in Fig. 9, 10, 11 and 12.

Fig. 3 – Specimen MSNM i23147, holotype (0.9x). Dotted lines in the drawing indicate structures preserved as imprints.
Fig. 3 – Esemplare MSNM i23147, olotipo (0,9x). Le linea punteggiate nel disegno indicano strutture conservate sotto forma di depressioni.

Fig. 4 – Part of the specimen MSNM i24817, paratype (0.7x). Dotted lines in the drawing indicate structures preserved as imprints.
Fig. 4 – Impronta dell'esemplare MSNM i24817, paratipo (0,7x). Le linee punteggiate nel disegno indicano strutture conservate sotto forma di depressioni.

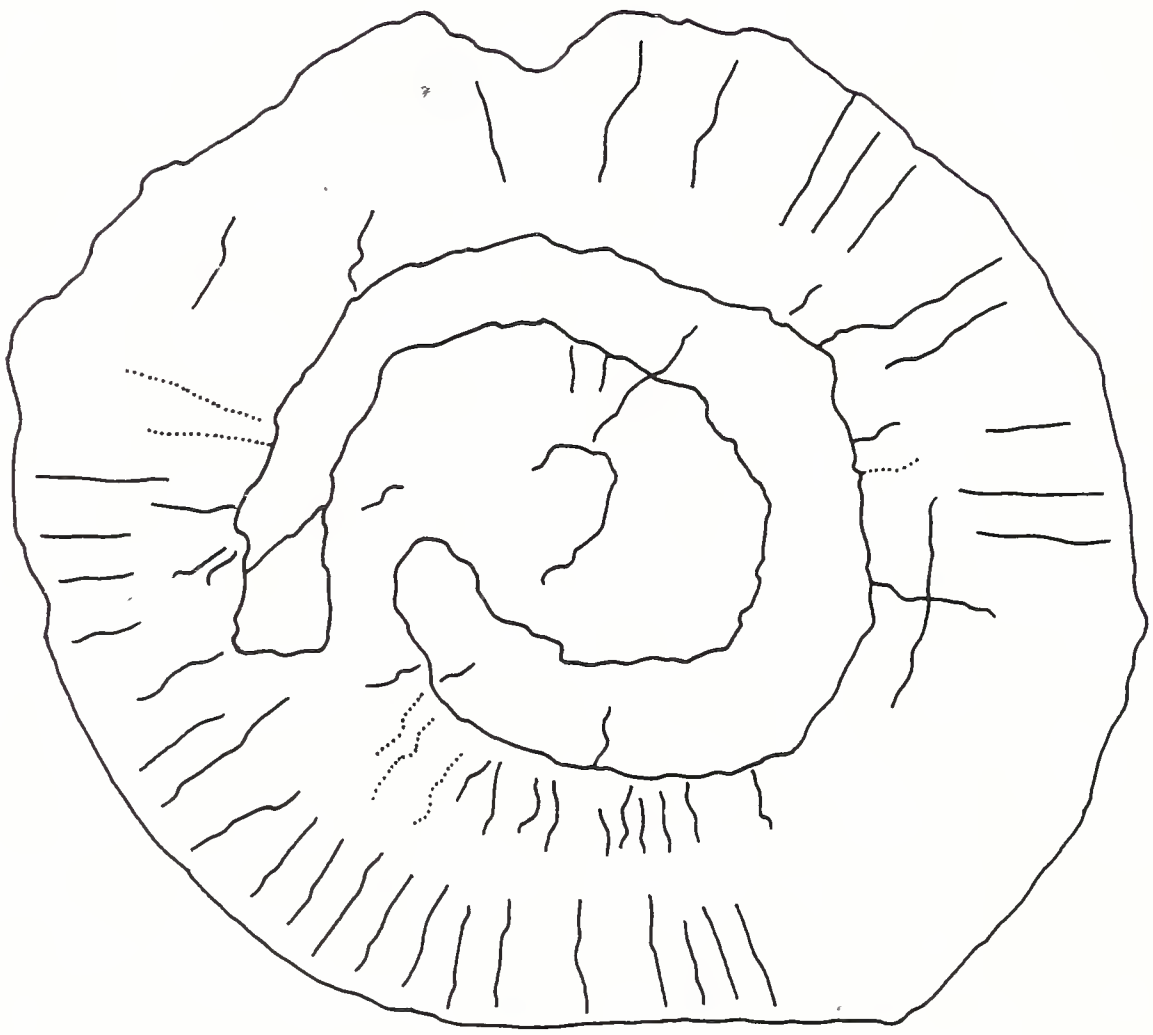

Fig. 5 – Counter part of the specimen MSNM i24817, paratype (0.7x). Dotted lines in the drawing indicate structures preserved as imprints.
Fig. 5 – Contro impronta dell'esemplare MSNM i24817, paratipo (0,7x). Nel disegno le linee punteggiate indicano strutture conservate sotto forma di impronta.

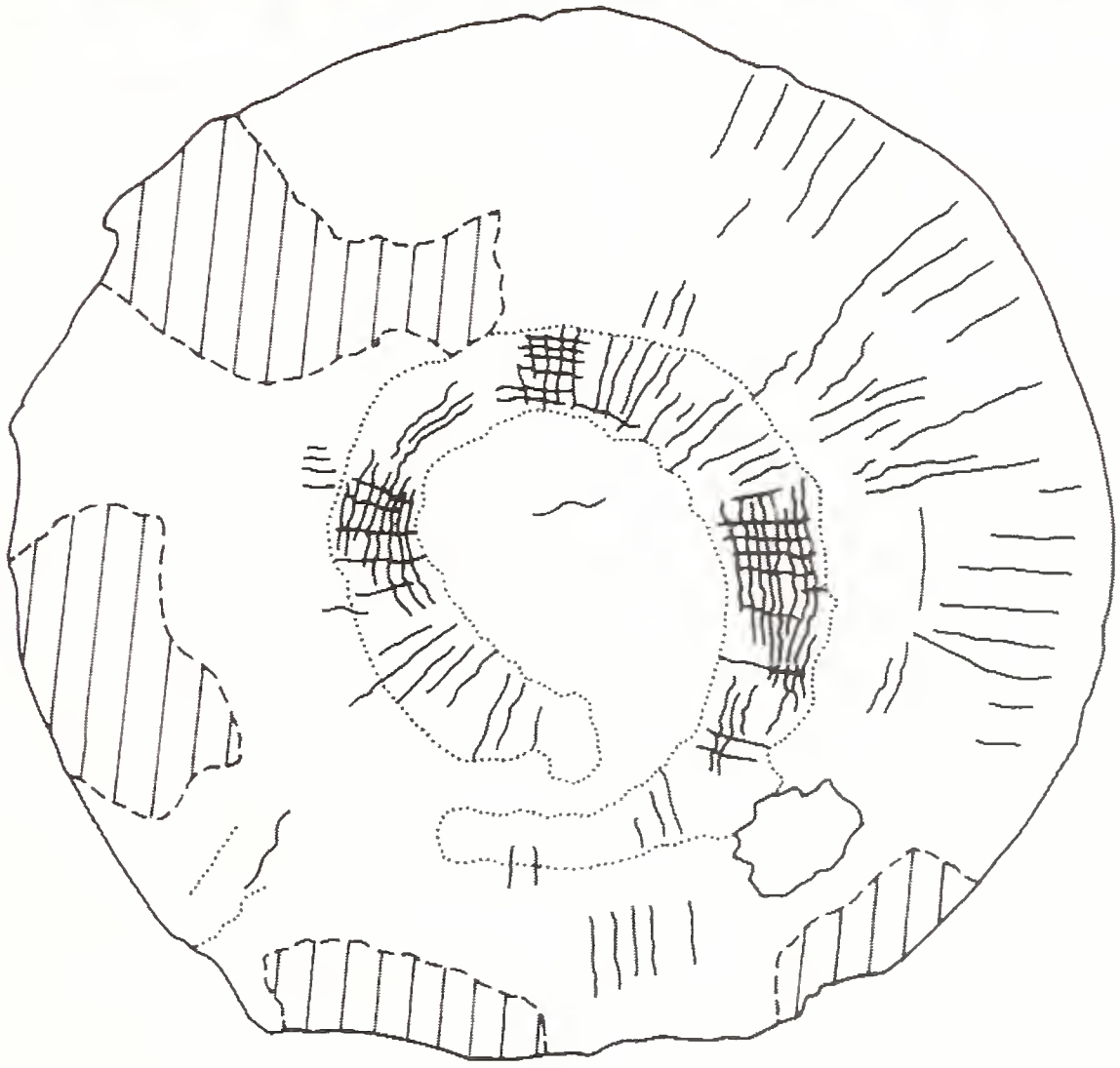

Fig. 6 – Specimen MSNM i24818#1, paratype (0.8x). In the drawing dotted lines indicate structures preserved as imprints, broken lines delimit not preserved areas.
Fig. 6 – Esemplare MSNM i24818#1, paratipo (0,8x). Nel disegno le linee punteggiate indicano strutture conservate sotto forma di impronta, le linee tratteggiate delimitano aree non conservate.

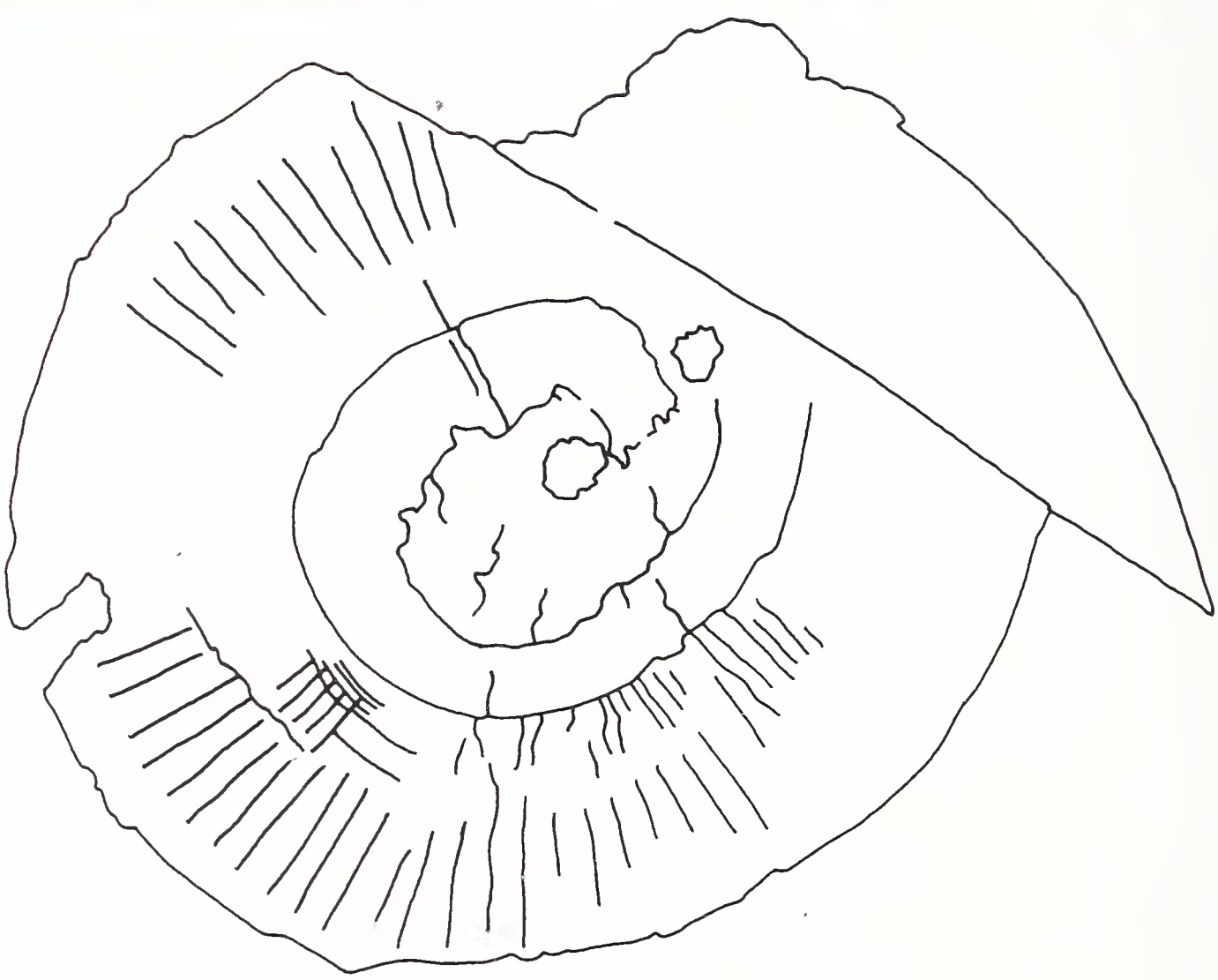

Fig. 7 – Specimen MSNMi24821, paratype (0.7x).
Fig. 7 – Esemplare MSNM i24821, paratipo (0,7x).

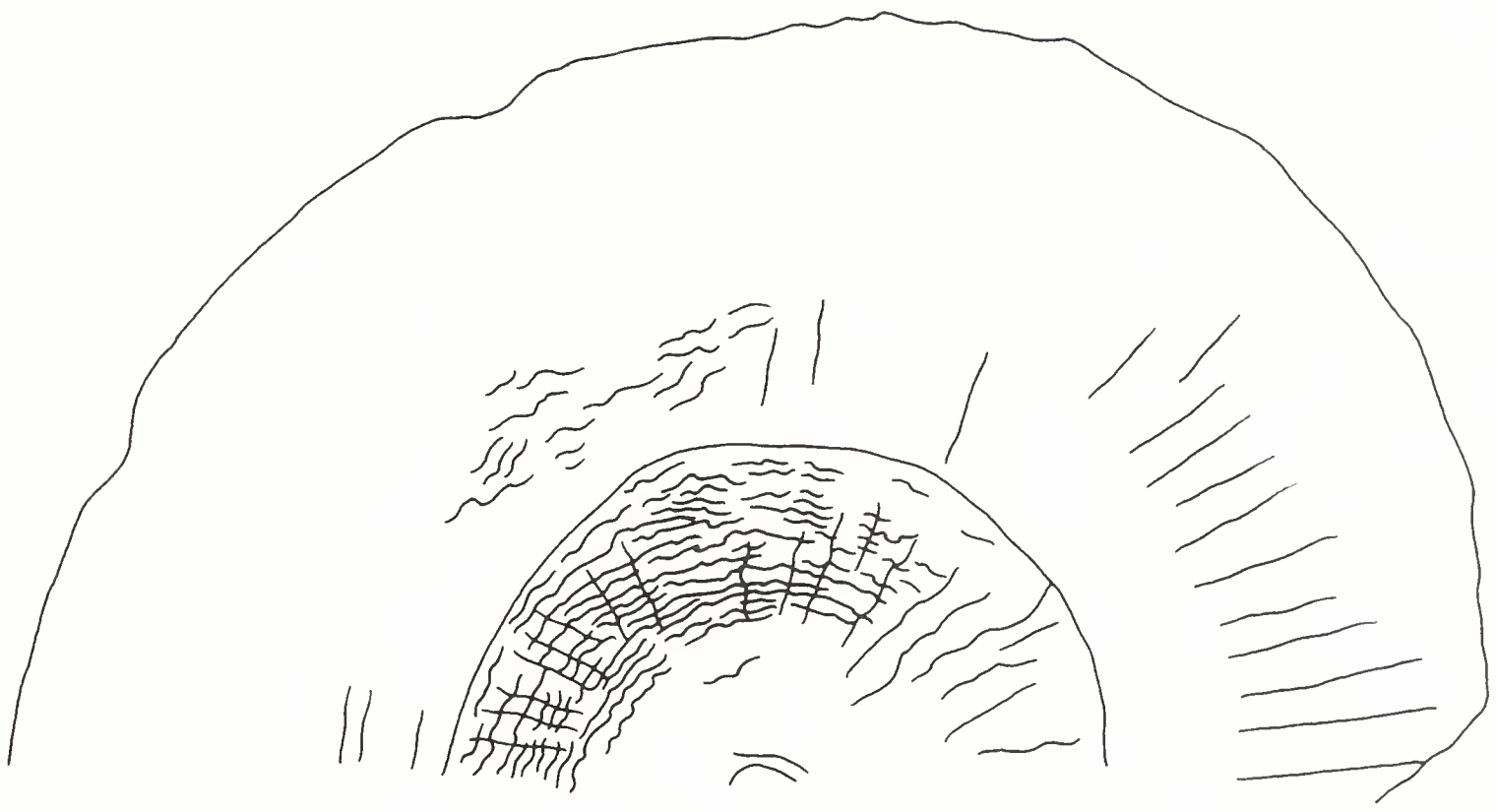

Fig. 8 – Specimen MSNM i25330#1, paratype (0.9x).
Fig. 8 – Esemplare MSNM i25330#1, paratipo (0,9x).

Tab. 3 - List of considered specimens of *Eldonia berbera* n. sp. Some observed characters: thread-like ridges of the outer ring (1), traces of radial structures of curved sac showing direct connection with those of outer ring (2), deep depression from mouth to anus surrounding the outer margin of the curved sac (3) and the feeding device (4).
Tab. 3 - Lista degli esemplari di *Eldonia berbera* n. sp. presi in esame. Alcuni caratteri osservati: creste filiformi dell'anello esterno (1), tracce di creste radiali del sacco curvo in connessione con quelle dell'anello esterno (2), profonda depressione circondante il sacco curvo dalla bocca all'ano (3) e il dispositivo di alimentazione (4).

	1	2	3	4
MSNM i22825				
MSNM i22843	•			
MSNM i23145				
MSNM i23147	•		•	•
MSNM i23148	•			
MSNM i23149				
MSNM i24815	•	•	•	•
MSNM i24816		•		
MSNM i24817			•	•
MSNM i24818#1		•		
MSNM i24818#2		•		
MSNM i24818#3				
MSNM i24819#1	•			•
MSNM i24819#2	•		•	•
MSNM i24819#3	•			
MSNM i24820				
MSNM i24821	•		•	
MSNM i24822	•			
MSNM i24823		•		
MSNM i24824	•			•
MSNM i24825	•		•	•
MSNM i24826#1	•		•	•
MSNM i24826#2				
MSNM i24827	•	•		•
MSNM i24828		•		
MSNM i24829	•			•
MSNM i24830	•		•	•
MSNM i24931				
MSNM i24832#1		•		•
MSNM i24832#2				
MSNM i24833	•		•	•
MSNM i24834				•
MSNM i24835		•		
MSNM i24836#1	•	•		•
MSNM i24836#2				
MSNM i25250	•			
MSNM i25251		•		
MSNM i25252				
MSNM i25253				
MSNM i25254				
MSNM i25255				

MSNM i25256				
MSNM i25257				
MSNM 25258				•
MSNM i25259	•			
MSNM i25260	•			•
MSNM i25261	•			
MSNM i25262	•			
MSNM i25263	•			
MSNM i25264	•			
MSNM i25265	•			
MSNM i25267	•			
MSNM i25268	•			
MSNM i25269#1				
MSNM i25269#2				•
MSNM i25270				
MSNM i25271#1	•			
MSNM i25271#2				
MSNM i25271#3				
MSNM i25321	•			
MSNM i25322			•	
MSNM i25323	•	•		•
MSNM i25324		•		•
MSNM i25325				
MSNM i25328				
MSNM i25327	•	•		
MSNM i25329		•		
MSNM i25330#1				
MSNM i25330#2		•		
MSNM i25331#1	•			
MSNM i25331#2				

Tab. 4 - Measurements of *Eldonia berbera* n. sp. (N=number of specimens, vmax=maximum value, vmin=minimum value, av=average, R=radius, Lap=outer ring maximum width, Lsc=curved sac maximum width, Cr=radial ridges). For more details see Figs. 9-12.
Tab. 4 - Caratteristiche morfometriche di *Eldonia berbera* n. sp. (n=numero di esemplari, vmax=valore massimo, vmin=valore minimo, av=media, R=raggio, Lap=larghezza mssima anello esterno, Lsc=larghezza massima sacco curvo, Cr=creste radiali). Vedi Figs. 9-12 per maggiori dettagli.

	N	**vmax**	**vmin**	**av**
R	59	90.25 mm	25 mm	60 mm
Lap	50	57 mm	13.5 mm	33 mm
Lsc	32	19 mm	6 mm	13 mm
Cr	53	132 units	28 units	79 units

Discussion: we assign the specimens to the genus *Eldonia* (Walcott, 1911) because of their medusoid morphology and the presence of the curved sac (Friend, 1995), also known as 'alimentary canal' (Walcott, 1911; Chen *et al.*, 1995), 'digestive tube' (Clark A.H., 1912 and 1913), 'gut' (Durham, 1971, 1972 and 1974), 'curved intestine' (Conway Morris & Robinson, 1988), 'coiled sac' (Chen *et al.*, 1995; Zhu *et al.*, 2002) or 'gastrozooid' (Madsen, 1956, 1957 and 1962). Other characters such as

the radial ridges, the feeding device, the central ring and the concentric thread-like ridges, all observed in Moroccan samples, are also typical of this genus. Some authors consider the feeding device as a 'lophophore' (Dzik, 1989; Chen *et al.*, 1995) and call the concentric thread-like ridges 'concentric muscle fibres' (Walcott, 1911; Clark A.H., 1912; Friend, 1995), 'concentric riblets' (Chen *et al.*, 1995) or 'concentric wrinkles' (Zhu *et al.*, 2002).

The Moroccan specimens are on average bigger than *E. ludwigi* and *E. eumorpha*. Diameter of *E. ludwigi* from Burgess Shale ranges from 6.7 cm to 12 cm (Briggs *et al.*, 1994), but these authors did not record the modal size. The maximum width of the curved sac (L_{sc}), measured on 498 specimens of *E. ludwigi* from British Columbia, ranges from 2 mm to 25 mm with a modal width from 5 mm to 6 mm (Friend, 1995). The diameter of *E. eumorphus* from China measured by Friend (1995) and Chen *et al.* (1995) on 1500 (1075 and 477 respectively) specimens, ranges from 25 mm to 115 mm, with an average of 60-65 mm and a modal diameter from 50 mm to 60 mm. In Erfoud specimens the diameter ranges from 5 cm to 18.05 cm and the modal diameter (42%) is from 10 cm to 12 cm, L_{sc} ranges from 6 mm to 19 mm and the modal width (78 %) ranges from 10 mm to 15 mm.

The number of radial ridges, also called 'radial canals' by Walcott (1911), Clark A.H. (1913) and Chen *et al.* (1995), 'mesenteries' by Durham (1971, 1972 and 1974), 'radial fibres' by Friend (1995), 'dactylozooids' by Madsen (1956, 1957 and 1962) and 'radiating canals' by Zhu *et al.* (2002), in the Moroccan specimens is not constant as in *E. ludwigi* and in *E. eumorpha*, but seems to be directly proportional to the disk radius and to the radius-outer ring width ratio. Neverthless Walcott (1911) and Friend (1995) in *E. ludwigi* from Burgess Shale, Conway Morris & Robinson (1988) in *E. ludwigi* from Utah and Chen *et al.* (1995) in *E. eumorpha* from China, observed about 40 lobes that are not preserved in *E. berbera* n. sp. These structures, which lie inside the body, are separated from each other by some radial ridges that Zhu *et al.* (2002) called 'mesenteries'. According to Chen *et al.* (1995) and to Zhu *et al.* (2002), lobes and mesenteries could represent the remnants of a water vascular system.

The tentacular structure observed in the feeding device (Walcott, 1911; Durham, 1974; Dzik, 1989; Chen *et al.*, 1995; Friend, 1995) and the organization of the digestive tube into oesophagus, stomach and gut (Walcott, 1911; Durham, 1974; Chen *et al.*, 1995; Friend, 1995; Zhu *et al.*, 2002), which are well preserved in *E. ludwigi* and *E. eumorpha*, are not recognizable in the Moroccan specimens.

Conclusions

The morphologic and morphometric characteristics observed on 71 specimens from Anti-Atlas justify the assignment of these specimens to a new species of *Eldonia*.

Unfortunately the poor preservation of the Moroccan specimens, which results at least in part from the coarse particle-size of the arenaceous matrix, does not allow us to consider the hypotheses that tentatively referred Eldoniidae to Hydrozoa (Madsen, 1956, 1957 and 1962; Seilacher, 1961), Scyphozoa (Lemche, 1960; Sun & Hou, 1987), Lophophorata (Dzik, 1989; Chen *et al.*, 1995; Zhao & Zhu, 1994; Dzik *et al.*, 1997; Zhu *et al.*, 2002) and Echinodermata (Walcott, 1911; Clark A.H., 1913; Durham, 1971, 1972 and 1974; Briggs *et al.*, 1994; Friend, 1995).

Therefore, like Clark H.L. (1912), Croneis & Mc Cormack (1932), Paul & Smith (1984), Conway Morris (1993b and 1998), Smith (1998) and Wills & Sepkoski (1993), we are unable to assign the family Eldoniidae to a higher taxon with reasonable certainty.

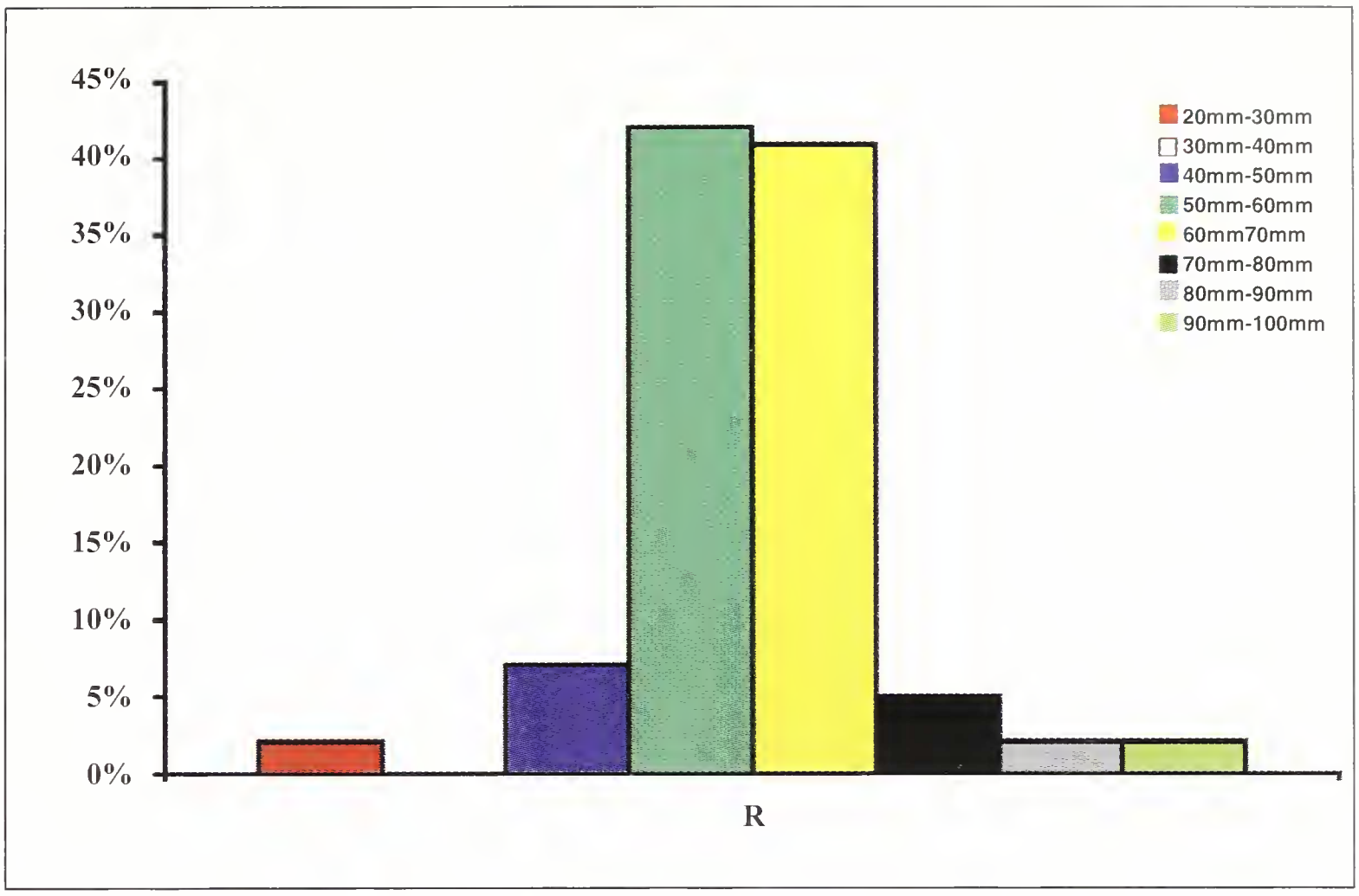

Fig. 9 – Radius (R) distribution frequency for 59 specimens of *Eldonia berbera* n. sp.
Fig. 9 – Frequenza di distribuzione in base al raggio (R) per 59 esemplari di *Eldonia berbera* n. sp.

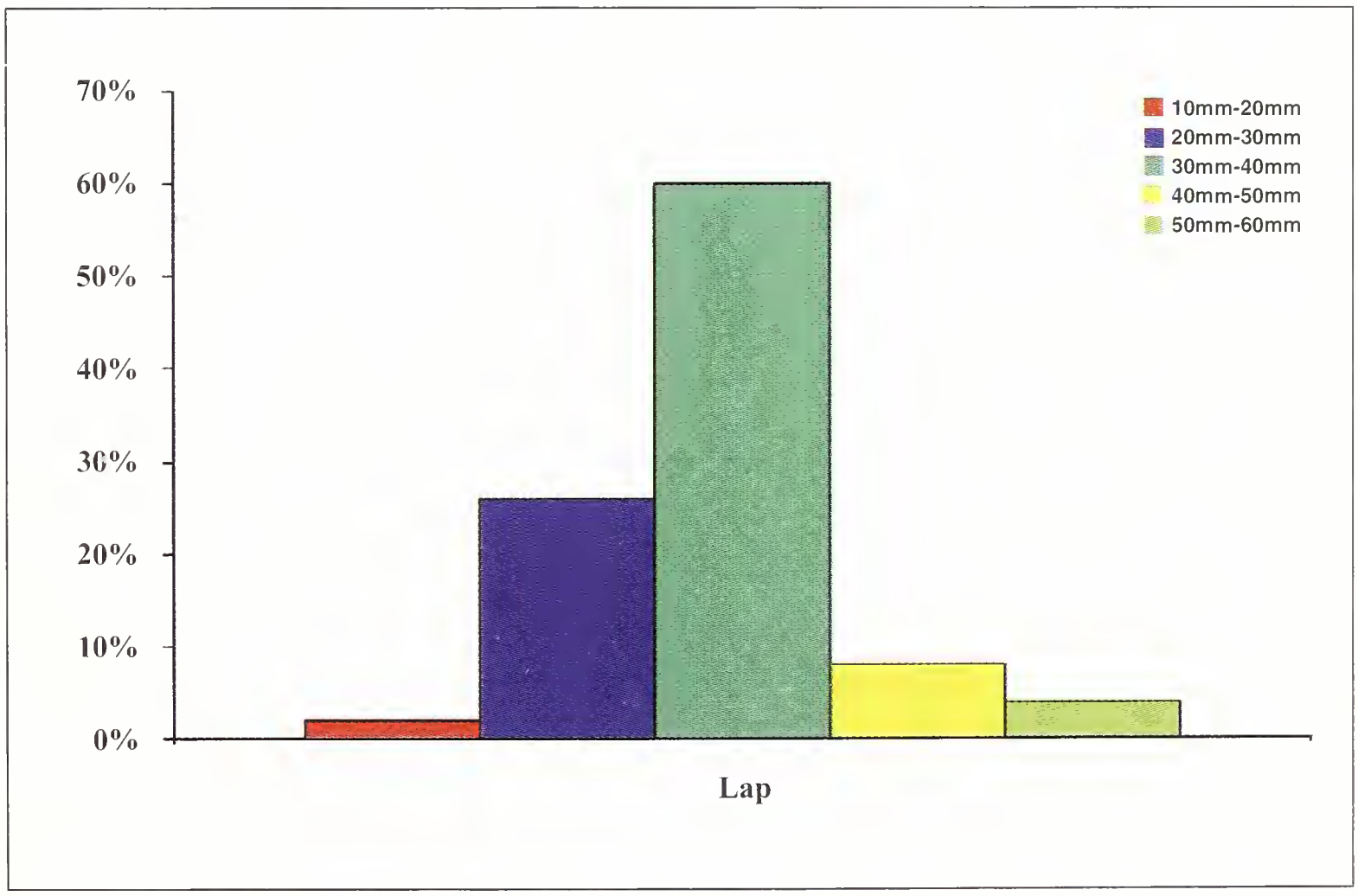

Fig. 10 – Outer ring maximum width (Lap) distribution frequency for 50 specimens of *Eldonia berbera* n. sp.
Fig. 10 – Frequenza di distribuzione in base alla larghezza massima dell'anello esterno (Lap) per 50 esemplari di *Eldonia berbera* n. sp.

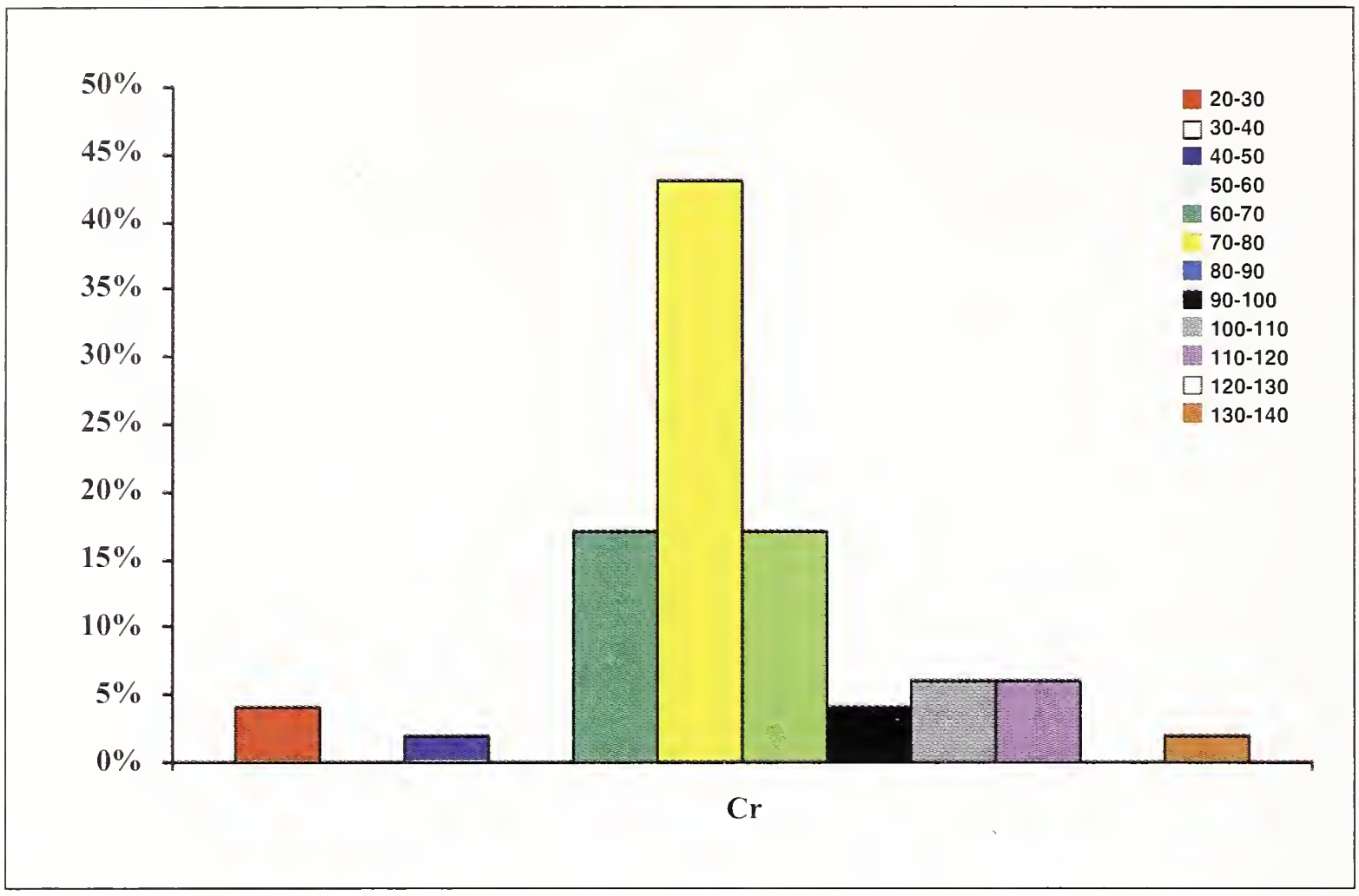

Fig. 11 – Radial ridges (Cr) distribution frequency for 53 specimens of *Eldonia berbera* n. sp.
Fig. 11 – Frequenza di distribuzione in base al numero delle creste radiali (Cr) per 53 esemplari di *Eldonia berbera* n. sp.

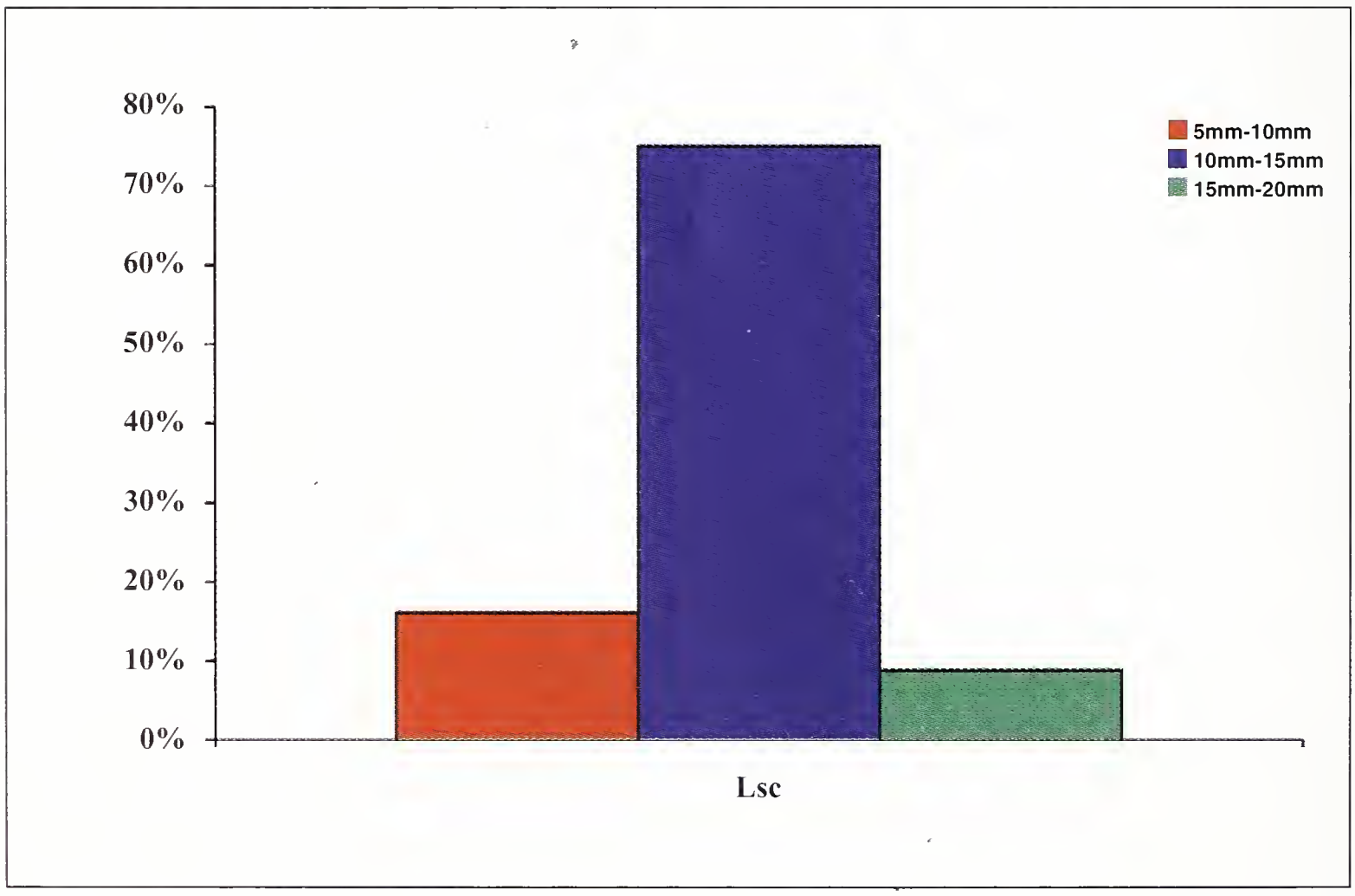

Fig. 12 – Curved sac maximum width (Lsc) distribution frequency for 32 specimens of *Eldonia berbera* n. sp.
Fig. 12 – Frequenza di distribuzione in base alla larghezza massima del sacco curvo (Lsc) per 32 esemplari di *Eldonia berbera* n. sp.

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